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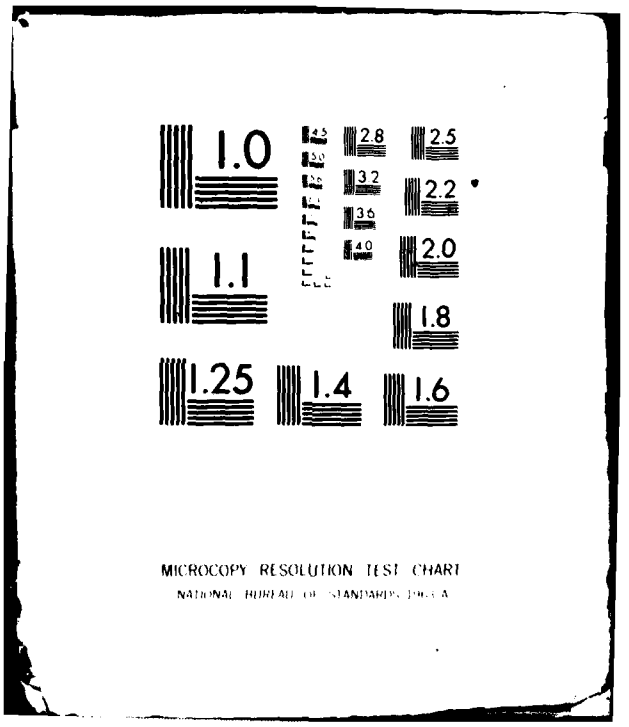
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Publication 1370-01-1-2209R

AD A094182

EXECUTIVE SUMMARY OF FINAL REPORT 1370-01-1-2209R

DESCRIPTION AND ANALYSIS OF TRENDS IN CONUS COMMON CARRIER OFFERINGS

November 1980

Prepared for
DEFENSE COMMUNICATIONS AGENCY
DEFENSE COMMUNICATIONS ENGINEERING CENTER
1860 WIEHLE AVENUE
RESTON, VIRGINIA 22090
under Contract DCA100-79-C-0039

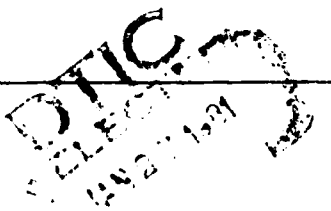
ARINC RESEARCH CORPORATION

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE	READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER (14) ARINC Publication 1370-01-1-2209R	2. GOVT ACCESSION NO. AD-A094 182	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) (4) Description and Analysis of Trends in CONUS Common Carrier Offerings • Executive Summary • (9)	5. TYPE OF REPORT & PERIOD COVERED Final Technical Report • June 1979-November 1980 •
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) (10) R.B. Mead R.J. Stark	8. CONTRACT OR GRANT NUMBER(s) (15) DCA 100-79-C-0039
9. PERFORMING ORGANIZATION NAME AND ADDRESS ARINC Research Corporation 2551 Riva Road Annapolis, Maryland 21401 (12) 16	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS (11) Defense Communications Agency Defense Communications Engineering Center (R720) 1860 Wiehle Avenue, Reston, VA 22090	12. REPORT DATE November 1980
	13. NUMBER OF PAGES 241
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) Same	15. SECURITY CLASS. (of this report) Unclassified
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited



17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

Same

18. SUPPLEMENTARY NOTES

DCEC Project Engineer: Walter G. Hartung (R720)

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Tariff Rates
Cost Regulation
Forecasting Communications
Telecommunications Economics
Integrated Digital Switching and Transmission Networks

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This study describes and analyzes trends in CONUS common carrier offerings. It identifies and quantifies factors affecting the cost of future offerings and provides a methodology to update the forecasts as economic scenarios change. Specific offerings considered include those of AT&E, MCI, SPCC, WUI, and RCA. Both terrestrial and satellite communications are included in the analysis.

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EXECUTIVE SUMMARY OF
FINAL REPORT 1370-01-1-2209R

DESCRIPTION AND ANALYSIS OF TRENDS IN CONUS COMMON CARRIER OFFERINGS

1. STUDY BACKGROUND

This report presents the results of a study designed to describe and analyze trends in CONUS common carrier offerings over the 15-year period 1980 to 1994. The work was conducted for the Defense Communications Agency (DCA), Defense Communications Engineering Center, Reston, Virginia, by ARINC Research Corporation.

DCA is responsible for the management, operations, planning, and systems engineering of the Defense Communications System (DCS), which is a diverse global communications system comprising a combination of leased and U.S. Government-owned facilities that are highly exposed to significant trends and forces (e.g., changing technology, competition, regulation, and free enterprise). These trends and forces, along with a growing variety of interstate alternatives for CONUS DCS transmission and switching services and facilities, have been recognized by DCA as presenting a highly dynamic and complex current and future economic and technical environment. Such an environment will substantially affect the engineering and architecture efforts associated with the DCS.

It is expected that the CONUS DCS will continue to procure services by leasing them; however, the exploration of alternatives to the current DCS configuration should consider the trends and forces affecting the services provided by CONUS common carriers, as well as the cost of these and associated services. These investigations will result in the assessment of DCS alternatives in terms of the potential economic savings and rate stability that may be realized by Government ownership or leased facilities (e.g., earth terminals or circuit switches) or through optimum configurations of AT&T and specialized common carrier offerings.

2. STUDY OBJECTIVES

The overall objective of this study was to develop a methodology for CONUS DCS planning in light of the many uncertainties in future common carrier offerings and rates. Specific objectives were as follows:

- To establish a data base of carrier costs for each of several relevant carrier service categories

- To describe the current tariffs and plans for each of the relevant carriers
- To identify, describe, and quantify the major factors affecting future services and costs for each of the relevant carrier service categories
- To project the form and rate bounds of future tariffs for each of the relevant carrier service categories
- To document the methodology for analyzing tariff trends and recommend a procedure to periodically revise the analysis of service trends

Meeting these objectives will provide DCA with a specialized data base and a means of analyzing the factors and costs associated with interstate tariffs.

3. ACTIVITIES AND ANALYSIS

The tasks and major subtasks performed to meet the objectives of the study are described as follows:

3.1 Task 1: Analyze CONUS Common Carrier Trends

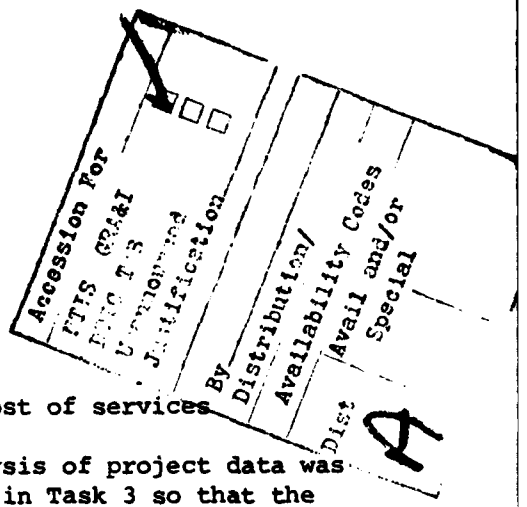
In Task 1 we identified and described trends in CONUS common carrier offerings, using various service filings, annual cost studies, and related data bases of interstate facilities. This analysis was designed to ascertain trends in the following segments of communications services:

- Terrestrial transmission services
- Satellite transmission services
- Access and tandem switching
- Satellite earth terminals
- Satellite space segments

In the analysis, we considered the following common carriers and equipment manufacturers:

- AT&T (interstate only)
- Western Union
- Satellite carriers such as American Satellite Corporation (AMSAT), Satellite Business Systems (SBS), and RCA
- Specialized terrestrial carriers (SCCs) such as Southern Pacific Communications Company (SPCC) and Microwave Communications, Inc. (MCI)
- Equipment manufacturers such as Harris, ROLM, and Northern Telecom

To determine which satellite and terrestrial carriers had the most complete financial and operating data, we reviewed filings and audits available for the carriers. Two SCCs and two satellite common carriers were selected for study.



Seven subtasks were performed during Task 1:

- Define services to be studied
- Determine data requirements
- Determine data sources
- Gather data
- Refine data and establish data base
- Analyze data and document trends
- Develop and document software to project cost of services

Most of the acquisition, refinement, and analysis of project data was accomplished in this task. Software was developed in Task 3 so that the cost of services might be econometrically extrapolated into the future, given a baseline economic scenario of trends in various cost-driving factors (e.g., inflation effects of labor, inflation in equipment costs, and effects of the infusion of new technology). This software was designed to accept scenarios of driving factors developed and assessed in Tasks 2 and 3.

3.2 Task 2: Describe Factors Affecting Future Service Offerings

In Task 2 we systematically researched and evaluated major factors affecting future service offerings in terms of their potential effects on service trends. These factors included Federal Communications Commission (FCC) docket issues, congressional actions, competitive forces, technology, and inflation.

Four subtasks were performed during this task:

- Review literature and document factors and potential effects
- Discuss certain actions, forces, and services with appropriate agencies and firms to assess factors and trends
- Develop a trend matrix relating factors to current or proposed services
- Assess the extent of each factor's benefit or detriment to the DCS

The assessments were used in Task 3 to prepare scenarios for assessing the collective impact of factors on cost of service.

3.3 Task 3: Assess Collective Impact of Identified Factors

In Task 3 we developed the following scenarios to provide the basis for assessing the collective impact of the factors identified in Task 2 on cost of service.

- A worst-case situation, in which factors combine to cause a significant increase in rates. This scenario includes a mixture of FCC proceedings and decisions, common carrier management decisions, the infusion of new technology, and inflation over the study period of 15 years, which may result in significant rate increases.
- A best-case situation, in which factors combine to cause a minimum impact on future rates. In this scenario all possible factors affecting a given service are allowed to combine in an optimum fashion, which may stabilize service rates over many years.

Seven subtasks were performed during this task:

- Develop and document possible scenarios for major issues, factors, and trends concerning technology and costs
- Develop a software model that will project trends, including scenarios that take influencing factors into account
- Establish and document estimation errors and confidence-interval bounds on trends
- Assess the likelihood and timing of emerging services
- Establish rate bounds and tariff forms for emerging services
- Exercise a computer model to predict trends in services with each major scenario
- Document trend details for specific categories of services and equipments

3.4 Task 4: Develop Procedures to Update Trends

Having predicted trends and the impacts of factors on service rates via the computer model developed in Task 3, we developed procedures with which DCA may update trends in services and equipment as costs and factor changes are hypothesized to occur. Four subtasks were performed during this task:

- Document the methods of analyzing trends and the algorithms employed in the study
- Document data sources
- Document the refined data base
- Document computer programs to be used in investigating trends and bounds

3.5 Task 5: Prepare Final Report and Briefing

When all aspects of the previous work activities were documented, a final report was drafted, coordinated with DCA for comments, put into final form, and delivered, with a formal briefing.

The following subtasks were performed during this task:

- Develop and coordinate a report outline
- Write the draft final report
- Coordinate the final report with DCA
- Include DCA comments in the final report
- Deliver the final report and briefing

4. SUMMARY OF FINDINGS AND CONCLUSIONS

The following sections summarize the significant findings and conclusions developed in the investigation of trends in CONUS common carrier offerings.

4.1 Trends of Current Services

The commercial telecommunications cost prediction and assessment model (CTC-PAM) was developed to use the technology and cost-related factor scenarios in predicting short-term (5 years) and long-term (15 years) cost trends. Inflation factors were then developed for the various service categories and carriers under study. These factors, summarized in Table 1, represent the median-case scenario, which lies econometrically between the best- and worst-case scenarios described earlier.

The inflation factors are useful in extrapolating current rates (i.e., 1980) into short-term (1987) and long-term (1994) rates. For instance, the terminal rate for AT&T's Multi-Schedule Private Line (MPL) service is currently $25.00 per month per service terminal end. The 1987 and 1994 rates may be estimated by finding the respective inflation factors in Table 1 and multiplying the current rate by the appropriate factor. In this example, the 1987 rate would be $25.00 × 1.113 = $27.83, and the 1994 rate would be $25.00 × 1.25 = $31.25.

We made a distinction between highly volatile and stable services. A service was classified as being highly volatile if (1) it is under heavy attack by the FCC, (2) it has a compound short-term inflation rate greater than 6 percent, (3) it is slowly being phased out by the carrier or by regulation and economic factors, and (4) it is expected to be restructured. Highly volatile services are listed in Table 2; all other services studied are considered to be relatively stable. The five services depicted in Table 2, i.e., MPL, Telpak, Dataphone Digital Service (DDS), Common Control Switching Arrangement (CCSA), and local distribution, are all AT&T services and are all heavily used in the CONUS DCS. MPL and Telpak are considered to be volatile, since the FCC has ruled that both are unlawful. MPL is expected to be restructured under the pending FCC proceedings, and Telpak is expected to be replaced by a new tariff offering that will provide specialized discounts to large-volume users. These discounts will

Table 1. SUMMARY OF SHORT-TERM AND LONG-TERM INFLATION FACTORS FOR SERVICES STUDIED

Service	1987 Inflation Factor	1994 Inflation Factor
AT&T		
• MPL	1.113	1.25
• Telpak	1.086	1.483*
• DDS		
•• 1.544 Mbps	1.73	2.96
•• 4.8 Kbps	1.732	2.979
• Local Distribution		
•• With Switching Access	1.700	2.800
•• Without Switching Access	1.634	2.757
• WATS	1.27	2.72
• CCSA	2.705	*
• EPSCS	1.40	3.01
MCI		
• Private-Line Service	1.40	2.1
• CCSA	1.57	2.91
• EXECUNET	1.40	2.0
SPCC		
• Private-Line Service	1.4	2.1
• SPRINT	1.42	2.1
WU Satellite Service	1.3	1.5
RCA Satellite Service	1.18	1.46
Terminal Devices		
• PBX under 500 Lines (Class 5)	1.46	2.219
• Over 500 Lines (Class 4/5)	1.452	2.191
• Tandem Switch	1.462	2.216
• Earth Terminal	1.46	2.21

*Service not expected to be offered.

Table 2. SERVICES CONSIDERED HIGHLY VOLATILE

Service	Reasons				Remarks
	1	2	3	4	
MPL	X	O	X	X	• Restructuring is expected under FCC proceedings. • Pricing is anticompetitive.
Telpak	X	O	X	O	• It will be withdrawn by AT&T concurrently with MPL restructuring. • Service has been under heavy attack for some time.
DDS	X	X	O	O	• It is under FCC attack because of anticompetitive rates.
CCSA (AT&T)	O	X	X	O	• Service has been made obsolete by introduction of EPSCS. • Rates are expected to increase significantly because investments cannot be reused.
Local Distribution (AT&T)	O	X	O	O	• Rates have been a primary economic hurdle to interconnection to OCC's service.

O - Reason does not apply.
X - Reason applies.

Reasons:

1. Service is under heavy attack by FCC.
2. Service has a compound short-term inflation rate greater than 6 percent.
3. Service is slowly being phased out by carrier, FCC, and economic factors.
4. Service is expected to be restructured.

probably reflect wholesale costs of service. It is also inevitable that AT&T will have to offer a less expensive, shared-use, measured-time or message-unit, point-to-point private-line offering for the smaller users of private lines.

DDS, CCSA, and local distribution are all considered to be volatile because of an excessive compound short-term (1987) inflation rate. DDS is a highly competitive service that has been under attack since its initiation. We expect this service to be contested heavily over the next 15 years from the standpoint of anticompetitive pricing. For this reason, the service will be relatively inflationary. DDS requires considerable maintenance and testing, because most data systems have a high level of quality control, and the requirement for circuit reliability is greater than that for the customary analog channels. As a result, the carrier will spend more maintenance dollars than normal, and the service will become more inflationary. CCSA is now outdated, since it is primarily based on older crossbar switching technology. Compared with the Enhanced Private Switch Communications Service (EPSCS), the service replacing CCSA, CCSA is not attractive. The introduction of EPSCS has caused large CCSA customers to migrate to EPSCS and abandon switching equipment that is now useless. As this migration accelerates, the level of CCSA pricing will have to be increased heavily because of the amortization of large CCSA investment costs. It is expected that this phenomenon will cause the service to become extremely overpriced by 1985 and to be completely withdrawn by 1987. Thus, the CCSA and the switched automatic network (SCAN) tariff offering (which provides the leased AUTOVON switching nodes) is almost certainly doomed to be withdrawn by 1987. The DoD must explore alternative methods of procuring its switching systems and must make plans that will exploit the advantages of newer digital switching technology and enhance competition by precluding a single-vendor approach to acquisition.

AT&T's local distribution is expected to increase in cost by 7.3 to 7.9 percent (short-term compound inflation rate) over the next seven years. It is expected that no significant changes in technology and maintenance will be placed into service, which may slow the increase in cost of local distribution. Many large corporations in cities of high circuit density will probably start setting up their own local distribution facilities (e.g., rooftop satellite terminals) to obtain a more stabilized and less expensive local distribution.

The services offered by MCI, SPCC, Western Union, RCA, and AT&T's WATS and EPSCS are expected to have short-term inflation rates of less than 6 percent per year. The most stable services are the RCA and Western Union satellite services, which are expected to have compound short-term inflation rates of 3.1 and 2.4 percent, respectively. These figures are low because of the relatively fixed transponder costs of the space link and the relatively low cost of the more inflationary earth terminals. We consider satellite services to be the most economic where the attendant delays are not a problem. WATS is considered to be exceptionally stable; however, the FCC has been looking at WATS in relation to the MTS, and there is concern about the structure of WATS in the short term and long term. We expect that

the FCC will allow a bulk-purchase service that is area-related (as opposed to point-to-point) in terms of stations that may be accessed, and that the rates for the service will be about as stable as the current WATS rates.

We believe that MCI and SPCC will experience significant growth and that their services will exhibit modest rates of inflation, because the SCCs employ all-new technology and are not "rate-base justified,"* but rather are commercial services that are as successful as their sales, use of capital, and productivity. We noted that MCI (as of February 1980) generates $118,000 in annual revenue per employee and that AT&T generates approximately $50,000 in annual revenue per employee. This contrast indicates that MCI is using new technology and achieving high productivity. It is also expected that the SCCs will utilize their facilities to a greater extent, because they will need to maximize their sales for any level of plant investment. A brief review of the tariff structures of the SCCs will verify the use of night and weekend rates that are substantially lower than business day rates. This practice is designed to obtain a higher degree of facility utilization and greater revenue generation per unit of investment.

4.2 Emerging Services

Our studies have shown that all the intercity services are, or will be, highly cross-elastic and interchangeable with AT&T's current MTS and its bulk equivalent, WATS services. The distinction between MTS and private line is arbitrarily drawn by price. That is, if MTS were cheaper than private line, given the average business's traffic patterns, there would be no need for private-line service. We believe that there is a continuum of possible services based on price and function. We expect that AT&T's private-line services will be restructured in terms of price, but that no new service will evolve. PBXs, tandem switches, and Class 4/5 switches will probably be offered by carriers for interstate use in a tariff format, because there is a substantial market for this type of service, given the economies of decentralized or distributed switching arrangements where much of the network intelligence resides in the carrier's backbone network. We expect that more data processing, electronic data interchange, word processing, and other information-related processing functions will appear as part of service offerings in combination with classical voice and data transmission and switching.

4.3 Beneficial Effects of Competition

We think that one of the major effects of competition has been to stimulate the telecommunications marketplace with the infusion of new technology, services, prices, and marketing endeavors. In effect, we are saying that the marketplace is now experiencing the beneficial effects of American free enterprise. We have indicated our belief that a continuous spectrum

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*That is, they are compensated not according to the size of their rate base, but according to their sales.

of services is possible. It is through creative and innovative competition that the gaps in this spectrum will be filled and customers will receive services and technology that they would not have received otherwise. We think, too, that free competition will provide the best kind of regulation. If an independent carrier is able to offer a service at a lower price than a monopoly, and if that carrier remains viable and financially stable, the marketplace has rejected the argument for monopoly. Thus, the FCC's decisions to allow competition have been a long step toward allowing the telecommunications marketplace to enjoy new technology and new ideas and generally to benefit from a broader spectrum of services and pricing.

4.4 Procurement of CONUS Common Carrier Services

Our studies have shown that changes are to be expected in economic, regulatory, judicial, and technology factors that can be extremely costly to the DCS. We have pointed out that economically stable alternative services exist, and that competitive forces are beneficial. We think that in planning the procurement of CONUS common carrier services, DCA should study the DCS to determine what services are cost beneficial, what the savings are, what kind of an organization is able to support a multivendor procurement environment, what services apply, and what the vulnerability considerations of the translated network are. Our study has shown that circuits may be procured at incremental mileage rates of $0.40 per mile from satellite carriers and $0.44 to $0.50 per mile from SCCs. The existing tariffs and service coverage of cities by no means exhaust the realm of transmission possibilities. For instance, it is conceivable that the DCS could lease radio channels for its major backbone city pairs and provide its own end-terminal and intermediate-terminal multiplexing. The leasing of microwave routes would be subject to interstate tariff, but the multiplexer equipment would not, since the equipment would be provided by the customer. In this plan the carrier would be responsible for maintenance of the microwave transmission system, and the customer (or his contractors) would be responsible for multiplexer maintenance. The benefits of this type of plan are as follows:

- The customer pays only for the multiplexing and transmission he maintains.
- The transmission system could be designed to support 1.544 Mbps to aid in economically interconnecting a digital-tandem switched network and various types of data systems.
- The customer is able to reduce or limit the amount of tariffed services subject to rate increases.
- A specialized system would be useful to provide quality control for a multicarrier and specialized transmission system lease.

This type of procurement is active and requires extensive coordination and planning, including the following:

- Establish and maintain a complete and accurate automated data base of tariff rates and projections of short-term and long-term trends.

- Establish and maintain a specialized data base of NCS circuit requirements, which may be easily processed by a computerized network architecture type of program.
- Develop computer programs that will build alternative networks from the specialized circuit data base and allow the network costs to be determined in the following terms:
  - Baseline cost for current vendor system
  - Least-cost multivendor network
  - Least-cost by number of selected vendors

All of these should include projections of short-term and long-term economic trends of the total network cost, given various factor scenarios, to determine the most economically stable vendor configuration.

5. THE HAWAIIAN EXEMPLAR

During the conduct of this study, the CTC-PAM was used to assist DCA in the economic analysis of the Hawaiian AUTOVON network. AUTOVON has the potential to produce economies in consolidating such services as DDD, WATS, FTS, and AUTOVON into a network referred to as the Defense Metropolitan Area Telephone System (DMATS). This type of network engineering and architecture is in keeping with DoD Directive 4650.5, which recognizes the economics of consolidations made possible by newer generations of stored program switches.

DCA's role in determining the most cost-effective and efficient means of providing transmission and switching facilities on the island of Oahu arose through a task statement to the Defense Communications Engineering Center (DCEC) from the Vice Director, Defense Communications Agency, which requested that DCEC review and evaluate cost, size, system control, and survivability of various alternatives for the provision of Hawaiian telecommunications requirements. Several programs and projects were in progress for improving telecommunications support to the National Command Authorities and the Commander-in-Chief-Pacific (CINCPAC) in Hawaii; these may be further improved by an integrated system approach. The various telecommunications systems include the following:

- AUTOVON - The Hawaiian Telephone Company has submitted an unsolicited proposal to replace an older Automatic Electric Company AUTOVON switch with a modern Northern Telecom DMS-200 digital switch.
- DMATS - The Department of the Navy is considering the implementation of a DMATS to replace the current Defense Administrative Telephone System (DATS).
- HAWS - DCA and the Department of the Navy, in accordance with a DoD memorandum, are implementing the Hawaiian Area Wideband System (HAWS), which is designed to replace individual leases of circuits

and services and provide for command control, performance improvement, protection of DCS traffic, and cost reduction.

- SVIP - DCA and the National Security Agency are proceeding with the Secure Voice Improvement Program (SVIP), which will increase the general availability of secure voice services on a worldwide basis by utilizing the AUTOVON network.

ARINC Research Corporation designed and added the DMATS feature to the CTC-PAM. DMATS is an extensive system that predicts and analyzes costs and trends; it incorporates substantial cost elements, algorithms, and various service cost structures that are currently in the CTC-PAM. In addition, DMATS was designed to have the following features:

- Up to 20 digital or analog switching nodes, which may be of eight different types (e.g., Northern Telecom DM-200 and Automatic Electric Company GTD-4600)
- Up to seven types of trunks (e.g., Telco Analog and Digital T1 Trunks)
- Three pricing methodologies, any one of which may be specified for a given node:
  - •• Classical telephone company pricing
  - •• Third-party lease with contract maintenance and operational management pricing
  - •• Owned equipment with contract maintenance and operational management pricing
- Pricing for transmission, which may be a mixture of classical telephone company lease pricing or SCCs and third-party lease with contract maintenance and operational management
- Input capabilities that allow the interactive input of a substantial integrated network, which may have a mixture of digital and analog switching and transmission technology along with a multivendor procurement capability for facilities
- Output capability, including:
  - •• Architecture and topology
    - Connectivity matrix
    - Node inventory
  - •• Network management
    - Connectivity matrix
    - Node inventory
    - Equipment type
    - Lines and trunks by type

- Financial Management
  - Initial cost inventory by nodes
  - Predictions of transmission and switching costs by nodes and technology types
- Statistics
  - Transmission costs
  - Switching costs
  - Percent increases over baseline

After the Hawaiian telecommunications systems alternatives were reviewed, the DMATS addition was designed and included in the CTC-PAM and turned over to DCEC for use in evaluating the alternatives.

6. BENEFITS OF THE STUDY AND AREAS REQUIRING FURTHER STUDY

The major benefits of this study include the following:

- The development of an extensive data base of interstate carrier service costs that can be directly used to project cost-of-service for major tariff offerings
- The development of the CTC-PAM, which is capable of analyzing trends in interstate services, given postulated inflation and technology scenarios
- The establishment of initial short-term and long-term projections of inflation factors for major interstate service offerings
- The recognition of the rapidly growing financial and operating strength of the other common carriers
- The recognition and examination of highly volatile interstate services
- A statement of the possible rates and trends of a restructured AT&T private-line service

We expect that DCA will require continued analysis of cost trends for existing and emerging services to test their economic viability as candidate tariffs for the DCS network. The CTC-PAM and data base will provide the tools for this type of investigation. Additional work in the following areas can provide a more complete assembly of tools:

- Building an interface for the CTC-PAM to allow the model to deliver time-variant rates to a multivendor pricing program
- Analyzing carrier cost trends, updating unit costs, adding new services, and refining the CTC-PAM's uses
- Constructing pragmatic transmission and switching system approaches to the advanced phases of the DCS and testing the resultant economic stability under various procurement approaches

- Integrating the use of the CTC-PAM into the normal planning function of the DCS to ensure that refinements are appropriate to DCS needs

7. PROJECT OVERVIEW

We found that, while an AT&T-based transmission and switching system may appear to be relatively stable at present, it will be subject to tremendous upward pressure in pricing because of economic, regulatory, and judicial factors. It is expected that major restructuring of interstate services will force large users to take a serious look at an integrated multivendor environment. Since AT&T is the price leader in the carrier business, it is expected that SCCs will be priced in relationship to AT&T and will provide a degree of discount that will balance facility lease with profits. For this reason, the encouragement of competition in the interstate marketplace will be beneficial in keeping prices of offered services in line. We expect that most interstate services will experience significant growth, and that diversification will provide new services and economic savings.

We have found that the interstate transmission facilities and tariffs are virtually tied up in regulatory proceedings, and that their rates will tend to be economically unstable. In this area of service, it is expected that the IBM/AETNA partnership (Satellite Business System) and Xerox (XTEN) type of services may aid in defining price and the structure of the marketplace. Since these services are young (e.g., DDS) or still in the planning stage, we expect that a commitment to an advanced digital voice and data network would be expensive and risky. At best, transition from a current carrier-based transmission and tandem-switching network should be evolutionary and use "safe" technologies. Such technologies would allow the newer concepts in trunking, maintenance, technical control, and switching to be easily accommodated.

We have also found, in the development of DMATS, that the capabilities of the CTC-PAM in analyzing trends may be invaluable in establishing the economics of integrated digital voice and transmission networks. These networks will become increasingly more important as cost trends drive the NCS CONUS telecommunications services into a minimum-cost multivendor and multiuser configuration.